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TITLE: EXPRESSIVE FEATURE MECHANISM FOR ANIMATED CHARACTERS AND DEVICES

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CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the priority of U.S. Provisional Application Serial No. 60/381,722 entitled "Expressive Feature Mechanism for Animated Characters and Devices" filed on May 17, 2002, the entire contents and substance of which are hereby incorporated in total by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a mechanical apparatus used to cause various expressions on the face of an animated character.

2. Description of Related Art

This invention pertains to an expressive feature mechanism used in an animated character. The goal of this invention is to achieve a full range of human-like and recognizable facial expressions. This goal has been addressed by others and has often led to the development of devices used in animated characters that have mouths, which open and close to mimic speaking or sucking. Examples of such work would be U.S. Pat No. 4,808,142 by Berliner, which has a motor driven mouth actuator to move the mouth between open and closed positions.

U.S. Pat. No 2,250,916 by Magruder uses electromagnetic coils to animate the upper and lower lip in synchrony to sound.

U.S. Pat. No. 3,841,020 by Ryan employs a complex set of levers and actuators that allow a range of facial expressions connected to the motion of a dolls arms.

U.S. Pat. No. 3,828,469 by Giroud describes a mechanism having two operating rods for moving upper and lower lips.

More recently issued patents describe techniques that allow for a greater control of lip motion. For example, U.S. Pat. No. 6,352,464 by Madland et al. describes a mechanism for an animated character. The Madland Patent describes a facial control system comprising of two lip chains embedded behind two lips. The lip chains are attached at either end as well as

at a center portion. By positioning the movable center portion relative to the moveable ends various facial expressions can be achieved, however, the described mechanism does not allow for stretching of the lips as it occurs on human and animal faces.

Other methods such as the one described in U.S. Patent No. 4,177,589 by Villa demonstrate a pneumatic mechanism to open and close the mouth. This method allows for a rounding of the lips but does not allow for a full range of expression such as a frown or broad smile.

Mechanisms such as U.S. Patent No. 6,544,098 by Hampton are capable of some recognizable expressions but only with the addition of other actions such as drooping ears or closing eyes.

The current invention comprises a means to make animated characters with complex facial expressions in a minimal component, minimal cost mechanism. With the described invention it is possible to make a full range of motions with a minimum of moving components.

SUMMARY OF INVENTION

Briefly described, the invention comprises of a pair of wheels or meshed gears used to generate human-like expressions. On each wheel or gear there is an attachment point and a device for inflecting or deflecting an elastomeric or flexible material or device. The primary goal of the wheels or gears is to stretch or allow for contraction of the elastomeric or flexible material or device attached to a point along a radius. Meshing of the gears allows for a reduction of drive sources while maintaining bilateral symmetry of motion. Independent wheels allow for asymmetric motion. In a meshed gear mechanism, one gear and its attachment point mirror the other in the pair. If one gear in the pair turns clockwise, the other gear in the pair turns counterclockwise. Since attachment points mirror each other on each gear of a pair, rotation of the pair would either increase or decrease the distance between each attachment point. An elastomeric or flexible material or device encircling the attachment points stretches or contracts as the gears turn. The inflection-deflection devices offer an increase in the recognition of an exaggerated expression produced by the bending of the elastomeric or flexible material or device.

A more rudimentary expressive system can be produced without the bending of the elastomeric or flexible material or device between its attachment points. The elastomeric or

flexible material or device can comprise a variety of conformations, ranging from a continuous band to a molded mask hiding and yet attached to the entire mechanism. The transmission of movement from the gears to the elastomeric or flexible material or device may also occur via indirect coupling such as magnetism.

The invention advantageously provides a moving lip mechanism for animated characters or devices that is simple in its design and construction. The device is capable of producing a range of motions in a range of speeds able to simulate a variety of expressions and mouth movements. With the synchronization of sound the device can simulate smooth, realistic vocalization.

This invention will be described further with reference to the following drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1a is an isometric view showing a pair of dual gear single drive mechanisms using motors with non-integrated encoding with the elastomeric material in place around attachment points on each of the gears.

FIG. 1b is a support frame removed isometric view showing a pair of dual gear single drive mechanisms using motors with non-integrated encoding with the elastomeric material in place around attachment points on each of the gears.

FIG. 1c – 1e are additional views showing a pair of dual gear, single drive mechanisms using motors with non-integrated encoding with the elastomeric material in place around attachment points on each of the gears.

FIG. 2 is an isometric view of an expression driving gear shown with an unused portion of its teeth removed.

FIG. 3a- 3l are various top views showing the gear arrangement and relative position of the attachment points and inflection-deflection points to present the elastomeric material in an expression.

FIG. 4a- 4c are isometric, top and side views respectively of a pair of dual gear, single drive mechanisms with the elastomeric material in place around attachment points on each of the gears.

FIG. 5a – 5c are isometric, top and side views respectively of a single drive four gear, rack and pinion mechanisms with the elastomeric material in place around attachment points on each of the gears.

FIG. 6a is a isometric view showing a pair of dual gear, single drive mechanisms with an angular offset and the elastomeric material in place around attachment points on each of the gears.

FIG. 6b is an isometric view showing a pair of dual gear single drive mechanisms with an angular offset.

FIG. 6c is a front view showing a single dual gear, single drive mechanism with an angular offset.

FIG. 6d-6e are top and side views respectively showing a pair of dual gear, single drive mechanisms with an angular offset.

FIG. 7a – 7d are isometric, front, side and top views respectively of a single drive, two gear, mechanism with the elastomeric material in place around attachment points on each of the gears and fixed points on the mechanisms frame.

FIG. 8 is an isometric view showing a pair of dual gear, single drive mechanisms with the elastomeric material being represented as a flexible mask in place around attachment points on each of the gears.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

During the course of this description, like numbers will be used to identify like elements according to the different views that illustrate the invention.

Referring to FIGS. 1a-1e, the mechanism **10,** according to the preferred embodiment, comprises a lower motor support frame **19,** an upper motor support frame **18** and a gear support frame **17.** The motor support frames secure two motors **20** and **22,** which in turn have small motor drive gears **24** and **26** respectively attached to their perspective drive shafts. Gears **24** and **26** mesh with reduction gears **28** and **30** respectively. The reduced diameters of reduction gears **28** and **30** mesh with primary expression driving gears **32** and **34** respectively. Positional sensing of the primary expression driving gear **32** is achieved by variable resistance or positional contacts on control board **40.** It is understood that other commercial means of encoding of position would be equally effective in positional sensing. Magnetic encoding, transmission slots counting, and reflective encoding are examples of other common methods of rotational encoding. Primary expression driving gears **32** and **34** in turn mesh with secondary expression driving gears **44** and **46** respectively. Each expression driving gear has one attachment point and one inflection-deflection pin affixed to a point in

relation to the radius of each respective expression driving gear. Each gears attachment point and inflection-deflection pin are at a fixed degree apart from one another. In the case of primary expression driving gear **32**, it has attachment point **60** and inflection-deflection pin **66** affixed. In the case of primary expression driving gear **44**, it has attachment point **62** and inflection-deflection pin **64** affixed. In the case of primary expression driving gear **34**, it has attachment point **56** and inflection-deflection pin **68** affixed. In the case of primary expression driving gear **46**, it has attachment point **58** and inflection-deflection pin **70** affixed. Fitted around the four attachment points is elastomeric material **80**. To prevent the return rotation of the primary and secondary expression driving gears, gearlocks **82** and **84** fits into the teeth of secondary expression driving gears **44** and **46** respectively. Gearlock **82** is allowed to release secondary expression driving gear **44** by being pulled by solenoid **90** and pivoted on axis **86**. Gearlock **84** is allowed to release secondary expression driving gear **44** by being pulled by solenoid **92** and pivoted on axis **88**.

FIG. 1a of the preferred embodiment illustrates an isometric view of the preferred embodiment of the mechanism **10**. In this view, the attachment points **56, 58, 60,** and **62** for holding the elastomeric material **80** represent lips, in a smiling expression. As used in this disclosure the term "attachment point" could be a post, a pin or any other projecting means capable of contact with, support of, or attachment to elastomeric material **80**. In the preferred embodiment, power to the motors **20** and **22** (see also FIG. 1b) is not applied once the desired position is sensed by control board **40**. Instead, position is maintained against the pull of elastomeric material **80** by securing against rotation with the gearlocks **82** and **84** (see also FIG. 1b). Rotation of the motors and change in expression of **10** as represented by the position of **80** is allowed by the activation of solenoids **90** and **92,** see also FIG. 1b, and the pull back of respective gearlocks **82** and **84**.

FIG. 1b of the preferred embodiment shows the same isometric view as FIG. 1a but with the removal of support frames **17,18,19** and circuit board **40** for clarity, see also FIG. 1a.

FIG. 1c and FIG. 1d also describe the preferred embodiment and show a right side and front view of the mechanism **10**. These views give clear perspectives of the relative positions of reduction gears **28** and **30** to their meshed small motor drive gears **24** and **26** and primary expression driving gears **32** and **34.**

FIG.1e also describing the preferred embodiment illustrates a top view of the mechanism **10**. This view would be the side that faces forward and represents the mouth of an animated character or design.

FIG. 2 describes an alternate embodiment of either the primary or secondary expression driving gear assemblies. In this figure, the gear **94** has been reduced in dimension to minimize overall construction size. Since only about 180 degrees of rotation is needed to reproduce most recognizable facial expressions, the non-meshed portions of the gear have been cut off. The support arm **94** would preferably be manufactured into a position that fits its need as a primary expression diving gear or secondary expression driving gear.

FIGS. 3a-3l illustrates examples of expression driving gear arrangements and their effect on the elastomeric material stretched around the attachment points. FIG. 3a, FIG. 3b and FIG. 3c show arrangements approximating a smile. FIG. 3d to FIG. 3g show expressions ranging from surprise to talking intermediates. FIG. 3h - FIG. 3k shows arrangements emulating sadness and anger. FIG. 3l shows the mechanism at rest.

FIGS. 4a-4c shows an alternate embodiment **11** of the preferred mechanism represented as **10** in FIGS. 1a-1e. In this embodiment, servo motors **100** and **102** replace the small motors as a means to drive the primary expression driving gears **104** and **106** respectively. This arrangement eliminates the need for a gearlock mechanism since position is maintained for as long as power is applied or until the servo receives instructions to reposition itself. The primary expression driving gears **104** and **106** mesh with secondary expression driving gears respectively. In this embodiment **11**, the attachment points **112, 114, 116**, and **118** are affixed directly to the expression driving gears **104, 106, 108** and **110**.

Referring to isometric FIG. 4a and top view FIG. 4b which illustrate a pair of dual gear single drive mechanisms, an elastomeric material **128** is placed in position in contact with attachment points **112, 114, 116**,and **118**. Gears **104** and **106** are attached to servo drives **100** and **102** respectively with integrated gear reduction and positional sensors. As motor drives **100** and **102** rotate, driving their attached gears **104** and **106** respectively, their meshed gears **108** and **112** in turn rotate in the opposite directions. The rotation of the meshed gears results in the radial displacement of the attachment points **112, 114, 116**, and **118**. As the gears **104, 106, 108**, and **110** rotate, the elastomeric material in contact with the attachment points **112, 114, 116**, and **118** gets pulled, or is allowed to contract, as the attachment points travel in a path defined by their placement on the gear's radius. In the event that the rotation

of the gears **104**, **106**, **108**, and **110** causes the inflection-deflection points **120**, **122**, **124**, and **126** to travel beyond a point defined by a line drawn between the two attachment points **112**, **114**, **116**, and **118**, the elastomeric material will be stretched to accommodate the radial movement of the inflection-deflection points **120**, **122**, **124**, and **126**.

FIG. 4c is a schematic side view of a pair of dual gear single drive mechanisms. Clarity is further enhanced in figures 4a and 4b by showing the relative positions of the drives **100** and **102**, the gears **104**, **106**, **108**, and **110**, the attachment points **116** and **118**, the inflection-deflection points **122** and **126**, and the elastomeric material **128**.

Referring now to isometric FIG. 5a and top view FIG. 5b of a single drive four gear rack and pinion mechanisms **12**, an elastomeric material **150** is placed in position in contact with attachment points **160**, **162**, **164** and **166**. Pinion expression driving gears **152** and **155** are meshed with racks **144** and **146** that can be moved by the action of levers **136** and **138** respectively. Levers **136** and **138** are rotated on their fulcrums **140** and **142** respectively by the force applied by pin **134** as the result of the rotation of wheel **132**. As wheel **132** attached motor drive **130** rotates, the displacement of levers **136** and **138** causes the movement of a racks **144** and **146** to rotate its respectively matched pinion expression driving gear **152** and **154**. The secondary expression driving gears **156** and **158** rotate in the opposite direction of their meshed primary expression driving gears **152** and **154** respectively. The rotation of the meshed expression driving gears **152**, **154**, **156** and **158** result in the radial displacement of the attachment points **112**, **114**, **116**, and **118**. As the gears rotate, the elastomeric material **150** in contact with the attachment points **112**, **114**, **116**, and **118** gets pulled, or is allowed to contract, as the attachment points travel in a path defined by their placement on the gears radius.

FIG. 5c is a schematic side view of a single drive four gear rack and pinion mechanism **12**. Clarity is further enhanced from FIG. 5a and FIG. 5b by showing the relative positions of the drive **130**, the wheel **132**, levers **136** and **138**, racks **144** and **146**, the pinion expression driving gear **154**, the attachment points **112**, **114**, **116**, and **118**, the inflection-deflection points **120**, **122**, **124**, and **126**, and the elastomeric material **176**.

FIGS. 6a, 6b, 6c and 6d illustrate an alternate embodiment **13** of the preferred mechanism represented as **10** in FIGS. 1a-1e. In this alternative embodiment **13**, servo motors **180** and **182** replace the small motors as a means to drive the primary expression driving gears **184** and **186** respectively. This technique eliminates the need for a gearlock

mechanism since position is maintained for as long as power is applied or until the servo receives instructions to reposition itself. The primary expression driving gears **184** and **186** mesh with secondary expression driving gears **188** and **190** respectively. In this alternative embodiment **13**, the expression driving gears **184**, **186**, **188** and **190** have their gear teeth set at an angle to allow the gears to rotate on separate planes. By setting the gears at an angle it is possible to better fit the model of a human or animal face, if desired. Attachment points **200**, **202**, **204** and **206** are affixed to support arms **194**, **198**, **196** and **192** respectively. Inflection-deflection points **212**, **214**, **208** and **210** are affixed to support arms **194**,**198**, **196** and **192** respectively. The support arms **192** and **194** are affixed to primary expression driving gears **184** and **186** respectively. The support arms **196** and **198** are affixed to secondary expression driving gears **188** and **190** respectively. An elastomeric material **216** is placed in position in contact with attachment points **200**, **202**, **204** and **206**.

Referring to isometric FIG. 6a illustrating a pair of dual gear single drive mechanisms, an elastomeric material **216** is placed in position in contact with attachment points **200**, **202**, **204** and **206**. Primary expression driving gears **184** and **186** are attached to servo drives **180** and **182** respectively with integrated gear reduction and positional sensors. As motor drives **180** and **182** rotate, driving their attached primary expression driving gears **184** and **186** respectively, their meshed secondary expression driving gears **188** and **190** in turn rotate in the opposite direction. The rotation of the expression driving gears **184**, **186**, **188** and **190** results in the radial displacement of the attachment points **200**, **202**, **204** and **206**. An elastomeric material **216** is placed in position in contact with attachment points **200**, **202**, **204** and **206**. As the expression driving gears **184**, **186**, **188** and **190** rotate, the elastomeric material **216** in contact with the attachment points **200**, **202**, **204** and **206** gets pulled, or is allowed, to contract as the attachment points **200**, **202**, **204** and **206** travel in a path defined by their placement on the expression driving gear's radius. In the event that the rotation of the attachment points **200**, **202**, **204** and **206** causes the inflection-deflection points **212**, **214**, **208** and **210** to travel beyond a point defined by a line drawn between two attachment points **200**, **202**, **204** and **206**, the elastomeric material will be stretched to accommodate the radial movement of the inflection-deflection points **212**, **214**, **208** and **210**.

FIG.6b is an isometric view of alternative embodiment **13**. Primary expression driving gear **186** and meshed secondary expression driving gear **190** are shown rotated so that support arms **194** and **198** present attachment points **200** and **202** in a position that would

reflect a smile similar to the one demonstrated in FIG.3a. The inflection-deflection points **212** and **214** then contact the elastomeric material to further stretch the material in the form of a smile.

FIG.6c is a side view of one servo drive **182** and one meshed pair of expression driving gears **186** and **190**. Removal of one drive and a meshed gear pair adds clarity to the view of how angular displacement of the expression driving gears **186** and **190** is achieved. The relative position of support arms **194** and **198** as well as attachment points **200** and **202** and inflection-deflection points **212** and **214** is visible.

FIG. 6d and FIG. 6e are top and side views, respectively, of alternative embodiment **13**. Primary expression driving gear **186** and meshed secondary expression driving gear **190** are shown rotated so that support arms **194** and **198** present attachment points **200** and **202** in a position that would reflect a smile similar to the one demonstrated in FIG.3a. The inflection-deflection points **212** and **214** then contact the elastomeric material to further stretch the material in the form of a smile.

Referring to FIGS. 7a-7d, the mechanism **14** further comprises of a lower motor support frame **234,** an upper motor support frame **232,** and a gear support frame **230.** The motor support frames secures one motor **236,** which in turn has a small motor drive gear **238** attached to the drive shaft. Gear **238** meshes with reduction gear **240.** The reduced diameter of reduction gear **240** meshes with primary expression driving gear **244.** Positional sensing of the primary expression driving gear **244** is achieved by variable resistance or positional contacts on control board **246.** It is understood that other commercial means of encoding of position would be equally effective in positional sensing. Magnetic encoding, transmission slots counting, and reflective encoding are examples of other common methods of rotational encoding. Primary expression driving gear **244** in turn meshes with secondary expression driving gear **242.** Each expression driving gear has one attachment pin and one inflection-deflection pin affixed to a point in relation to the radius of each support arm's respective expression driving gears at a fixed degree apart from one another. In the case of primary expression driving gears **242,** it has attachment point **252** and inflection-deflection pin **262** affixed. In the case of primary expression driving gear **244,** it has attachment point **254** and inflection-deflection pin **260** affixed. Attachment points **256** and **258** are fixed to an immobile point in such a way as to allow for attachment of elastomeric material **264.** Fitted around the four attachment points is elastomeric material **264.** To prevent the return rotation

of the primary and secondary expression driving gears, gearlock **248** fits into the teeth of secondary expression driving gear **244**. Gearlock **248** is allowed to release secondary expression driving gear **244** by being pulled by solenoid **250** and pivoting around an axis.

FIG. 7a is an isometric view of the of the mechanism **14.** In this view, the attachment points **252,254,256,and 258** are shown holding the elastomeric material **264**, representing lips, in a smiling expression. In this embodiment, power to the motor **236** is not applied once the position is sensed by control board **246**. Instead, position is maintained against the pull of elastomeric material **264** by securing against rotation with the gear lock **248**. Rotation of the motor and thus change in expression of **14** as represented by the position of **264** is effected by the activation of solenoid **250** and the pull back of gearlock **248**.

FIG. 7b of this embodiment illustrates a top view of the mechanism **14**. This view would be the side that faces forward and represents the mouth of an animated character or design.

FIG. 7c and FIG. 7d of this embodiment show a side and top view of the mechanism **14**. These views give clear perspectives of the relative position of reduction gear **240** to its meshed small motor drive gear **238** and primary expression driving gear **244.**

FIG. 8 is a completed unit **15** illustrating placement of an elastomeric mask **220** around a pair of dual gear single drive mechanisms **11** as represented in FIG. **4**a. In this figure the inflection-deflection points engage ridges or grooves embedded in the material of the mask's construction. Accordingly, the invention can include an elastomeric material which is either a circle with a hole therein, or wherein the attachment points and inflection-deflection pins touch the elastomeric material or engage ridges therein, or which the hole may be alternatively comprised of continuous elastomeric membrane material surrounded by elastic lip sections.

While the invention has been described with reference to the preferred embodiment thereof it will be appreciated by those of ordinary skill in the art that modifications can e made to the parts that comprise the invention without departing from the spirit and scope thereof.